

## **Development of the Redox Flow Batteries with Mini-Size for Electricity Storage System**

B.-Z. FANG, Y.-Z. WEI, T. ARAI, S.  
IWASA and M. KUMAGAI  
INSTITUTE OF RESEARCH &  
INNOVATION  
1201, TAKADA, KASHIWA, CHIBA,  
277-0861, JAPAN

To develop an efficient electricity storage system using redox flow battery (RFB) technology, a novel RFB which uses a glassy carbon with highly specific surface area as electrodes and a porous silica glass (Vycor Glass) with high chemical stability as a membrane has been manufactured. The microstructures of the electrode and membrane materials utilized for this RFB were examined with scanning electron microscopy technique. The configuration for the novel battery is presented. The performance of this RFB, which employed all-vanadium ions in 2 M sulphuric acid solution as electrolytes, was experimentally examined and evaluated by using the cyclic voltammetry, constant-current charging and discharging technique and electrochemical impedance spectroscopy. The results of the cyclic voltammetry measurements indicate that at the glassy carbon electrode the electrochemical window for 2 M  $\text{H}_2\text{SO}_4$  solution could reach 2.1~2.4 V. The half-cell reactions for the battery were electrochemically quasi-reversible at the glassy carbon electrode. Electrochemical impedance measurement indicates that area resistivity for the Vycor Glass membrane (1.4 mm in thickness) in 1 M  $\text{VOSO}_4$  - 2 M  $\text{H}_2\text{SO}_4$  solution is  $5.3 \Omega \text{ cm}^2$ . The batteries could deliver a specific energy of 24 Wh/L at a current density of 22 mA/cm<sup>2</sup>. The open-circuit

cell voltage, after full charging, remained constant at  $1.45 \pm 0.05$  V for over 72 hours, while the coulombic efficiency was over 91%, showing that there was negligible self-discharge due to cation diffusion through the membrane during this period. However, voltage efficiency of the battery was low (about 61%) and this was mainly attributed to the high area resistivity of the Vycor Glass membrane. Selection of improved membrane materials and optimisation of fabrication methods are being attempted for improving the battery performance.